



ADMINISTRATIVE REPORT

Report Date: June 26, 2018
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Meeting Date: July 25, 2018

TO: Standing Committee on Policy and Strategic Priorities
FROM: General Manager, Planning, Urban Design and Sustainability
SUBJECT: Sea Level Rise Planning Update

RECOMMENDATION

- A. THAT Council receive the following report for information regarding the key outcomes of the Coastal Flood Risk Assessment project and proposed next steps in implementing coastal flood protection in the City's vulnerable areas.
- B. THAT Council instruct staff to prepare and bring forward for consideration for referral to public hearing amendments to the Zoning and Development By-law to establish requirements for safe and flood resilient development in flood plains with applicable policies, guidelines and any consequential by-law amendments.
- C. THAT Council direct staff to develop by-laws, regulations, and policies to guide the design of engineered shoreline flood protection such that it is adaptable and built to a consistent performance standard.
- D. THAT Council approve up to \$500,000 in funding from the City's 2018 Innovation Fund, contingent upon securing matching external funds, to support the implementation of a sea level rise design challenge that will engage local, national, and international experts, residents and businesses to develop implementable, cost-effective and holistic solutions for the City's most flood-vulnerable areas.

REPORT SUMMARY

This report provides Council with a summary of the key outcomes of the third and final phase of the Coastal Flood Risk Assessment (CFRA) program, as well as an outline of the next steps of the City's sea level rise planning efforts. The CFRA project has provided the City with a thorough understanding of its risk and vulnerabilities with sea level rise, and a roadmap for moving forward with implementation. This report seeks Council's approval on several key next steps. First, the report recommends that the

City's Zoning and Development By-law be amended to ensure that new developments provide adequate setbacks from the coastline to allow for future flood infrastructure. The report also recommends by-laws, regulations and policies be developed to guide the design of coastal flood protection infrastructure, to ensure that it meets a consistent performance standard and is adaptable over time. Lastly, the report recommends the City launch a sea level rise design challenge to advance solutions for the most flood-vulnerable areas. With roughly \$1 billion of flood management infrastructure needed in Vancouver by 2100, building public awareness and support will be critical. A high-profile design challenge, modelled on successful programs implemented in New York City and San Francisco, would engage local, national and international experts, along with local residents and businesses, to co-develop implementable designs. This approach is expected to deliver outcomes that are more holistic, and with greater community buy-in, than a traditional public consultation process.

COUNCIL AUTHORITY/PREVIOUS DECISIONS

April, 1986: City Council endorsed specific flood-proofing policies for the Southlands flood plain.

January, 1987, City Council added Provincial flood-proofing standards to the Southlands policies and for other flood plain areas adjacent to the Fraser River, False Creek, Burrard Inlet, and English Bay. The Vancouver Charter was subsequently amended to enable implementation of flood-proofing policies via the City's building permit process. The policies were amended in 1995 and again in 2007.

July 2012: City of Vancouver approved the Climate Change Adaptation Strategy, recommending that staff undertake a suite of priority actions, including conducting a Coastal Flood Risk Assessment program to determine the potential impacts of sea level rise on the coastline of the City of Vancouver.

May 2014: The results of the first phase of the Coastal Flood Risk Assessment were presented to Council, along with information about proposed Phases II and III. Council approved raising the flood construction level from 3.5 m to 4.6 m within an expanded flood plain area to improve flood resilience of new buildings. The Vancouver Building By-law was amended to reflect these changes.

November, 2016: Staff presented the results of the second phase of the Coastal Flood Risk Assessment to Council, which including a high-level evaluation of response options for each of the flood-vulnerable areas in the City.

CITY MANAGER'S/GENERAL MANAGER'S COMMENTS

The City Manager supports the approval of the foregoing recommendations.

REPORT

Background

Sea level rise and flood risk

Vancouver, like other coastal cities around the world, will experience sea level rise and increasingly intense storm surge events over the coming decades and centuries due to climate change. Based on modelling results from the Intergovernmental Panel on Climate Change, the BC government recommended in 2011 that local governments plan for 1 metre of local sea level rise by 2100, and an additional 1 metre by 2200. The province's recommendation is expected to be updated following the next IPCC report, in 2022.

The City of Vancouver has been an early leader in planning for sea level rise. In 2012, Council approved the City's first Climate Adaptation Strategy. Within that strategy, the Coastal Flood Risk Assessment (CFRA) program was recommended as the top priority action. Over the past six years, the CFRA program has modeled a range of sea level rise and storm surge scenarios, assessed how the City might be affected by these flood hazards, and identified what options exist to adapt our coastline and minimize harmful impacts of flooding. Phase I of the CFRA was completed in 2014, Phase II was completed in 2016, and Phase III, the final phase of the CFRA program, was completed in June 2018.

CFRA Phase I

The first phase of the CFRA project modelled and mapped the current (e.g. 2013) and future flood hazard (e.g. 2100 and 2200) risk in Vancouver under different storm surge scenarios. These scenarios were recommended by a technical advisory committee that included the Province, regional government, academics and staff. A complex computer model, with detailed topographic data, was used to determine flood extent and depth under each of these scenarios, across the entire city. The modelling approach used has since been adopted by the Province and other organizations, including the Fraser Basin Council, to model regional flood hazard.

CFRA Phase I confirmed that Vancouver is most vulnerable to flooding caused by the combined effect of a coastal storm surge and a king tide (exceptionally high tides that typically occur in December and January) rather than river-related flooding caused by spring run-off. In addition to mapping the areas vulnerable to flooding, Phase I also identified the community assets, infrastructure and buildings at risk to flooding over time. With one metre of sea level rise and a major storm surge event (0.2% AEP storm surge event¹), approximately 13 sq. km of land and buildings valued at \$7B (2013 land value assessment) is vulnerable to flooding in Vancouver. This information highlighted the importance of planning now for sea level rise and of prioritizing our efforts, such that critical infrastructure and vulnerable populations are protected first.

¹ AEP – Annual Exceedance Probability. This is a measure of the likelihood and size of a storm and its increased water levels. In this case a “major storm” means that there is a 0.2% chance of a major storm surge event occurring in any given year. A 0.2% AEP storm surge event may also be described as a 1:500 year storm surge event.

At the completion of Phase I, Council approved an amendment to the Vancouver Building By-law to increase the minimum flood construction level (FCL) from 3.5 m to 4.6 m (geodetic). The FCL applies to new construction in the flood plain area and is based on one metre sea level rise combined with a 1-in-500 year storm surge. At that time, the City's designated floodplain was also updated (Appendix A – City of Vancouver Flood Plain map). Most neighbouring municipalities have now also raised or are in the process of raising their FCL to similar levels.

CFRA Phase II

CFRA II executed a high-level assessment of flood management options for flood hazard areas within the City, in order to inform future public consultation. As part of Phase II, a high-level scan was completed of flood management best practices implemented in other leading jurisdictions around the world. Through the Phase II work, it became clear that much of Vancouver's coastline will likely require flood protection, due to the high value of the park space and amenities, industrial land, critical infrastructure and—in some cases--the large number of residents in these areas.. Phase II also highlighted that preferred approaches will need to emphasize cost effectiveness, adaptability over time, and, wherever possible, should offer co-benefits such as habitat restoration and enhanced walking and cycling paths.

CFRA Phase III

The final phase of the CFRA program delivers a tool, referred to as the Sea Level Rise Planning Framework (Appendix B – Sea Level Rise Planning Framework), that uses outputs from CFRA I and II and a risk-based methodology to prioritize flood management planning and implementation across the city. The methodology uses information such as sea level rise projections, ground elevations, asset information, and risk tolerance to produce a timeline of when specific assets or infrastructure will require adaptation measures, and when larger-scale measures need to be in place.

For example, a particular area of the city may not need flood protection until 2050, but a park located along the shoreline within that area may need to be gradually raised before then to avoid frequent nuisance flooding. Similarly, a particular piece of infrastructure, such as a sewer pump station, may need to be raised or flood-protected prior in advance of having area-wide flood protection infrastructure in place, due the critical nature of the pump station. The Sea Level Rise Planning Framework will enable the City to make appropriate capital planning decisions moving forward, such that flood protection infrastructure is in place when needed.

The framework does not tell the City what to do in terms of designing adaptation actions. Rather, it takes a “pathways approach” to planning for sea level rise by acknowledging that while not all decisions can be made now, they can be anticipated, prioritised, and prepared for while remaining responsive to changing circumstance such as re-development, future climate change uncertainties, and stakeholder values. In addition, CFRA Phase III provides guidance as to how the City can monitor local sea levels and integrate updated sea level rise information into land-use and infrastructure decisions (described further in Appendix C—Sea Level Rise Monitoring Plan). Together, the tools developed through CFRA Phase III will help guide the prioritization and implementation of coastal flood protection moving forward.

Strategic Analysis

The CFRA program has provided the City with a comprehensive understanding of our flood risk and vulnerability, and a high-level understanding of the potential options available to protect or adapt various areas of the City. The next phases of work will focus on implementation, using the tools and information gained through the CFRA project.

By-law and policy development

In 2014 the Vancouver Building By-law was amended to raise the flood construction level of new buildings in designated flood plains. To ensure adaptation at the broader neighbourhood level, staff recommend amending the Zoning and Development By-law to ensure that flood plain development is done in a manner, through the provision of an adequate flood setback, that protects people, property, and the natural environment from the consequences of flood hazards and to enable future flood management infrastructure (Recommendation B). Securing an adequate setback at the time of develop is critical as it will enable future infrastructure to be adaptable over time. Failure to secure space now could mean more costly—and less desirable—solutions in the future.

In addition to amending the Zoning and Development By-law, staff are proposing to bring forward by-laws, regulations, and policies to guide the design of shoreline flood protection, to ensure that this infrastructure is adaptable and built to a consistent performance standard (Recommendation C). There is a need to have a consistent performance standard for flood protection in place now, as opportunities to design and implement flood protection in specific locations will arise in the coming years as part of capital projects and new development applications. The by-laws, regulations and policies will ensure flood infrastructure is properly built, but will need to also enable flexibility and unique planning and design considerations from one area to the next.

Critical infrastructure assessment and funding strategy

As part of shaping future adaptation approaches, more information about regional critical infrastructure and tools to fund coastal flood protection is needed. In partnership with the City's Chief Resilience Officer and Office of Risk Management, staff will pursue a critical infrastructure analysis that focuses on determining the interdependencies of critical infrastructure and the potential impacts of flooding on those systems. This type of "cascade analysis" will bring together critical asset owners (e.g. Fortis, BC Hydro, TransLink, etc.) to determine how infrastructure failures could impact Vancouver services and residents. This type of exercise will help further prioritize capital planning needs moving forward for both the City and other asset owners.

In addition, staff will also begin developing a long-term funding strategy to support implementation of coastal flood protection. The long-term funding strategy will identify criteria, tools, and funding opportunities available to the City of Vancouver that could be used to support the planning and construction of flood management infrastructure. The cost of implementing flood management solutions will depend on the options selected. It is important to note that coastal flood protection is not the sole responsibility of the City, as strategic partnership and long-term funding commitment from senior levels of governments is crucial for a sustainable program. Staff will report back to Council at a

future date with more information about funding requirements, revenue options and a sustainable financial strategy for flood management over the longer term.

Sea level rise design challenge

In 2017 and 2018 staff conducted a public awareness campaign around sea level rise that engaged roughly 15,000 people. By the end of the campaign, it was clear that awareness of sea level rise and local flood risk was relatively high, and many people were interested in participating in future planning efforts. Staff have also hosted several workshops with Fraser River residents and businesses this spring, and supported a similar workshop hosted by the Musqueam First Nation. The response from workshop participants has been quite positive, with participants expressing interest in exploring future adaptation approaches and being part of the planning process moving forward.

In parallel, staff have been exploring models for community engagement from around the world that address large-scale, complex challenges like sea level rise. One such model is the 100 Resilient City program, “Rebuild by Design”. Coastal cities such as New York City and San Francisco have carried out Rebuild by Design programs in response to Superstorm Sandy (New York City) and in anticipation of the impacts of sea level rise and coastal storms (San Francisco). Design challenges like Rebuild by Design typically require consulting teams to draw from both local and international expertise, as well as from a diverse range of perspectives (e.g. engineers, biologists, indigenous, social and economic advisors, etc.). In addition, the design challenge model requires the design teams to work closely with residents, businesses and other stakeholders to ensure that the proposed solutions reflect local priorities and concerns.

Like New York City and San Francisco, the City of Vancouver must address the new and complex challenges of sea level rise with innovative tools and processes. The City must start planning and engagement now as adaptation solutions are required in some areas now, others by 2050, and most by 2080. Over the next year staff will plan and seek grants to support an innovative sea level rise design program that will:

- Engage and educate residents and businesses about climate change, sea level rise and flood risk;
- Attract diverse thinkers and designers, both locally and internationally, who specialize in disciplines such as public engagement, urban design, flood management, and green infrastructure; and
- Deliver conceptual designs for shoreline flood protection that are holistic, cost-effective and implementable.

With an estimated \$1 billion of flood management infrastructure needed in Vancouver by 2100, building public awareness and support is critical. The benefit of a design challenge approach, as compared to traditional public consultation, is that it can build community support through participation in the design process. Further, a design challenge can result in more holistic solutions that address not only sea level rise, but also habitat enhancement, improvement to local walking and cycling facilities, as well as other social and economic benefits. Lastly, a design challenge can elevate the profile of sea level rise, beyond what a traditional public consultation process might achieve.

To that end, staff recommend funding be approved to support the development and launch of a sea level rise design challenge, as a way to engage residents and business

and advance coastal resilience solutions in the City's most flood-vulnerable areas (Recommendation D). Staff propose that the focus of Vancouver's sea level rise design challenge be False Creek and along the Fraser River, but that neighbouring municipalities and other organizations be approached as well, to potentially broaden the scope to a more regional effort.

Implications

Financial

The report recommends that up to \$500,000 be allocated from the City's 2018 Innovation Fund to support the planning and implementation of a sea level rise design challenge for the City's most flood-vulnerable areas. This engagement and design work is a necessary next step to advance the City's sea level rise work. The program will deliver comprehensive engagement programming and conceptual coastal flood management designs. Staff will be required to source a minimum of \$500,000 of matching external funds in order to receive the City's funding (Appendix D).

Staff will commence work on developing a sustainable financial strategy and senior government partnership opportunities to advance the implementation of coastal flood protection and report back to Council for consideration.

Environmental

Vancouver's coastline includes important habitat for fish, birds and other wildlife that is locally and globally significant. Intertidal habitat will be impacted, reduced, and squeezed over time with sea level rise. Thoughtful planning for sea level rise can create opportunities to restore and replicate intertidal habitat by using softer—and greener--flood management approaches that also protect waterfront properties.

CONCLUSION

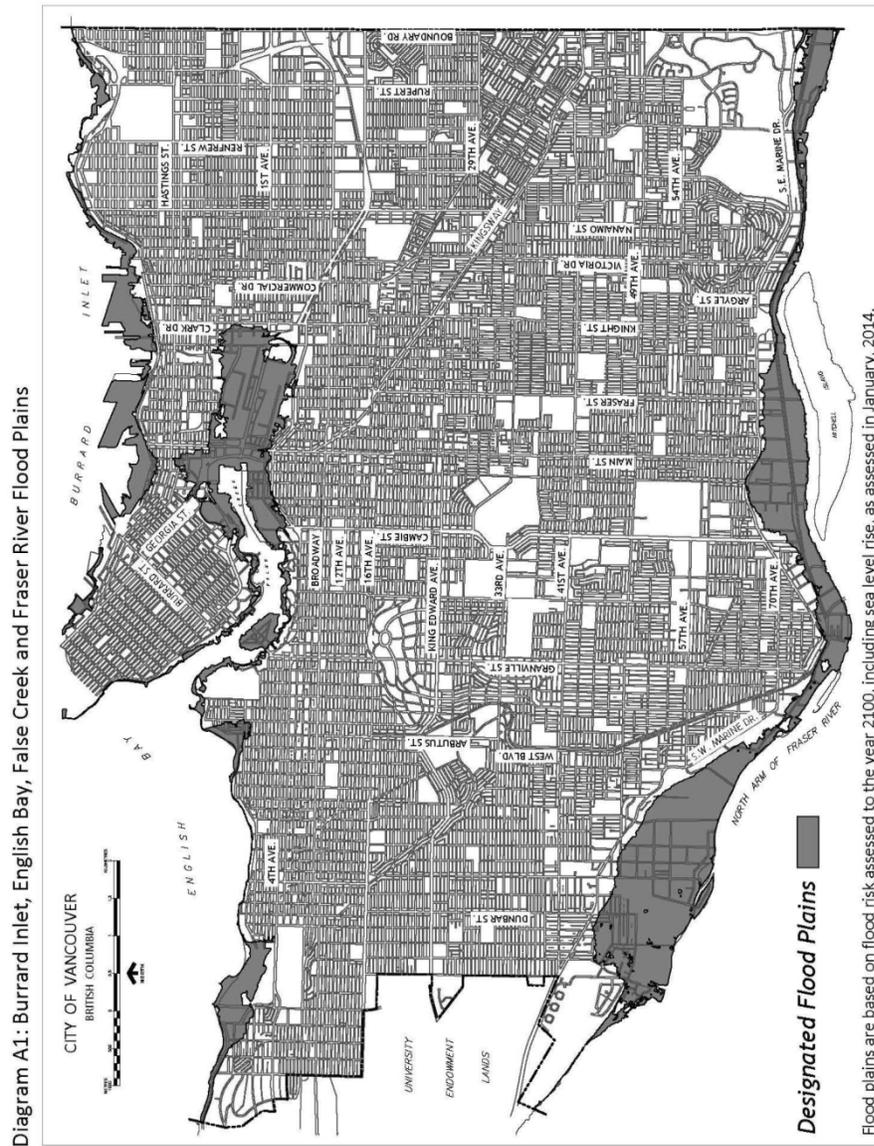
Adapting to sea level rise will be a long-term ongoing process. The CFRA project has identified where and how the City of Vancouver is vulnerable to coastal flooding, and provided approaches and timelines for implementing adaptation measures. With the information gained through the CFRA project, the City is now well positioned to begin implementation. To that end, staff recommend that amendments to the Zoning and Development By-law be brought forward for consideration to ensure buildings are adequately setback from the coastline, and that new bylaws and policies be developed to guide the design of flood protection in the City. Further, this report recommends funding be provided to support the development and launch of a sea level rise design challenge, as a way of engaging with residents, businesses and stakeholders and advancing design solutions to make Vancouver's coast more resilient.

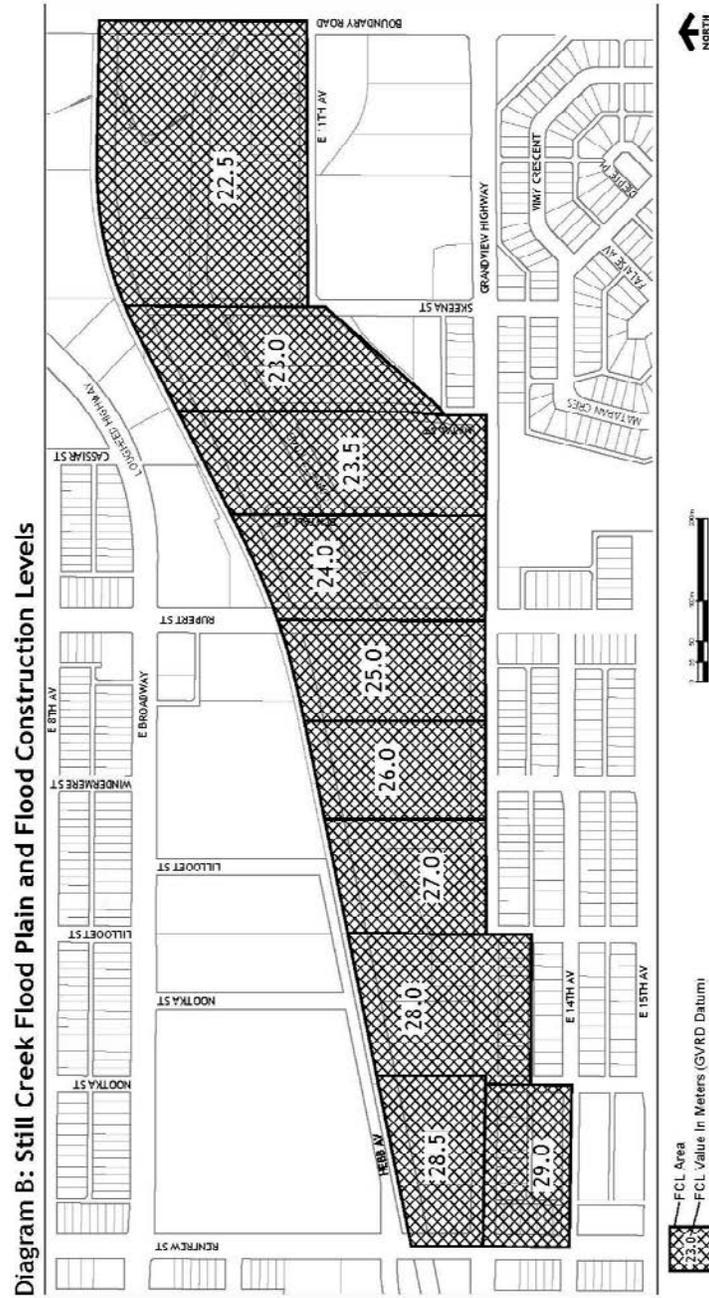
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City of Vancouver Flood Plain map

(from the City of Vancouver's Flood Plain Standards and Requirements)

Appendix B - Flood Plain Diagrams





Sea Level Rise Planning Framework

Vancouver, like all coastal cities around the world, will experience sea level rise and increasingly intense storm surges over the coming decades and centuries. In accordance with a recommendation from the Province, the City is planning for one metre of sea level rise by 2100, and two metres by 2200. The Coastal Flood Risk Assessment (CFRA) project was undertaken to better understand the City's risks and vulnerability to coastal flooding over time, and to provide a high-level road for implementing solutions.

As part of the CFRA, a set of guiding principles was established to help steer the City's sea level rise planning efforts:

- Use the best available science and practice adaptive management;
- Seek adaptable, green and robust solutions that can be phased over time;
- Seek flexible “no regret” actions with co-benefits;
- Pursue funding strategies based on value and equity;
- Take advantage of opportunities that arise through infrastructure lifecycles and land redevelopment;
- Take a risk-based approach; and
- Be resilient by providing redundancy.

Through the outputs of the CFRA project, it is clear that the flood risks faced by the City are not homogeneous. Some areas will flood sooner or more frequently than other areas, due to their elevation or exposure to the ocean. Flood-vulnerable areas also vary in terms of the specific assets at risk (e.g., infrastructure, buildings, public amenities, etc.). Given these variations, planning and implementing flood management across the City must be done using a strategic, risk-based manner that allows for flexibility and adaptation over time.

Based on the outputs of CFRA Phases II and III, a timeline was created to help guide flood management planning going forward. The timeline, which identifies thresholds for engagement, design and implementation, is presented in Figures 1 and 2 below.

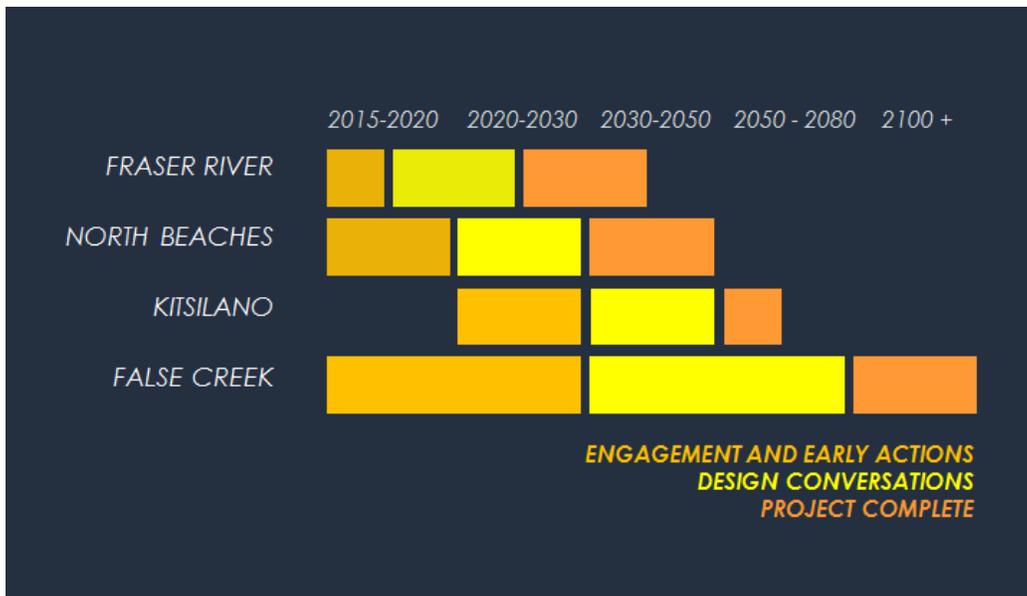


Figure 1: Timeline for implementing engagement, design and construction for major flood hazard areas in Vancouver.

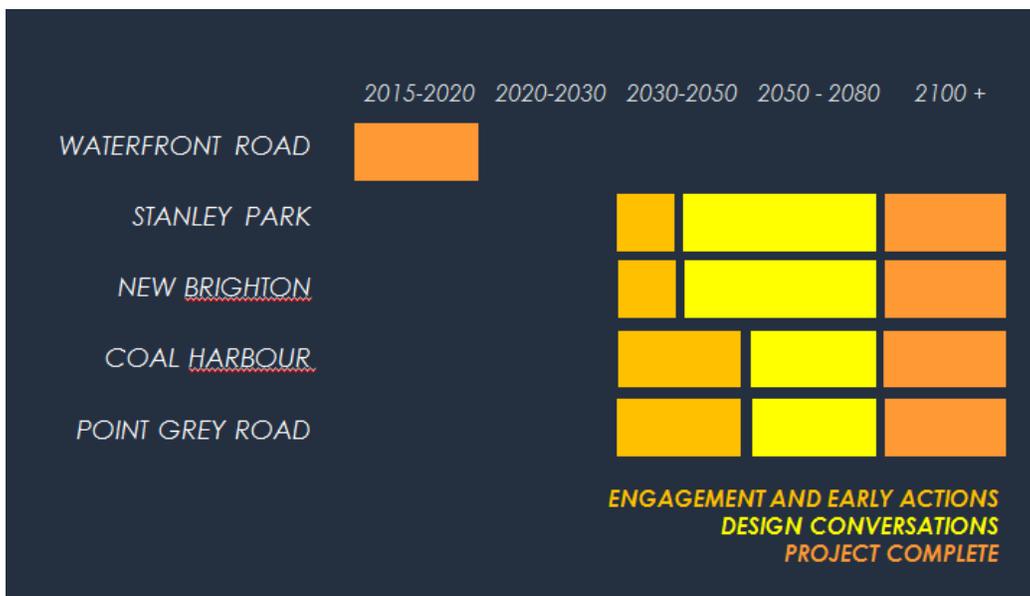


Figure 2: Timeline for implementing engagement, design and construction for secondary flood hazard areas in Vancouver.

The final phase of the CFRA program provided a tool, the Sea Level Rise Planning Framework (Figure 3), to further prioritize flood management efforts. The methodology uses information such as sea level rise projections, ground elevation, asset mix, and risk tolerance. On a site-by-

site basis, the Sea Level Rise Planning Framework produces a timeline of when specific assets and zones will require adaptation interventions, in response to nuisance, moderate, and major flooding between now and 2100. The timeline enables staff to identify and prioritize investment and planning needs around the coastline.

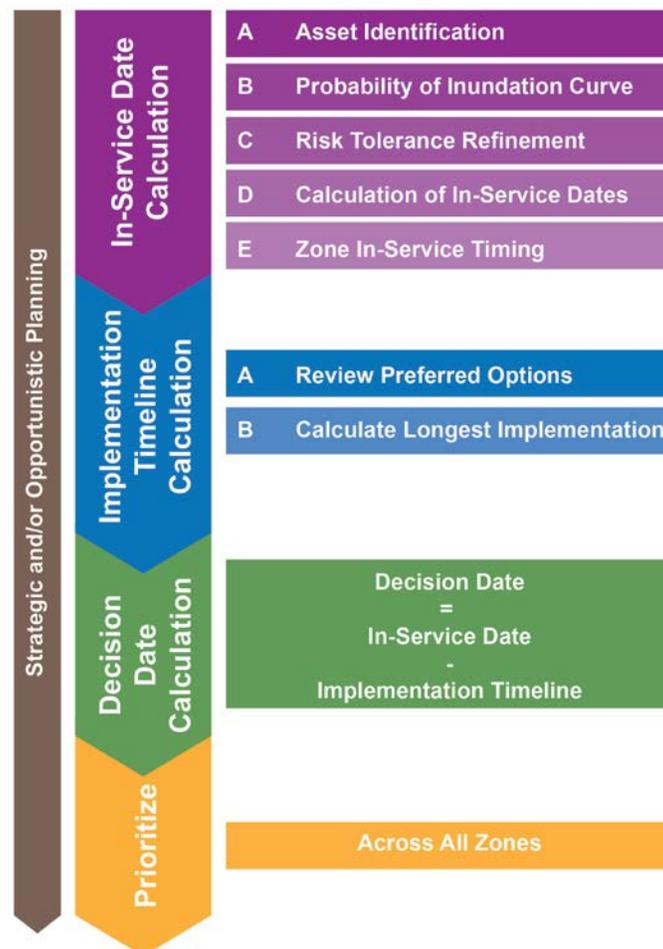


Figure 3: The Sea Level Rise Planning Framework provides a step-by-step methodology to determine when specific assets as well as zones need to be protected or adapted.

The Sea Level Rise Planning Framework can support decision-making in several ways:

1. At a zone-level, the framework can be used to make decisions about individual assets and/or the zone as a whole. It can help the City understand how small actions (like retrofitting a single asset) can buy time for an expensive zone-level adaptation action. The range of available approaches becomes apparent once the framework is applied.
2. At a City-level, once the framework is applied to all zones, the results can be used to inform prioritization of actions across zones. For example, zones with earlier drop-dead dates may be prioritized over others with later dates. This framework therefore provides

a robust and transparent method to support what will be difficult decisions for City Council.

3. At both the zone and City-level, the components of the framework (asset maps, timelines, etc.) can be used to support engagement and education of the public, stakeholders and City staff. The framework can also be used to support the case for funding (from senior-level governments) for adaptation dollars.

Sea Level Rise Monitoring Plan

For the purposes of this and earlier work, the B.C. guideline of 1 m of sea level rise by the year 2100 has been adopted. However, we expect that as science progresses, and as time passes and we better understand how much sea level rise has already occurred locally, that the sea level rise curve will shift. The rate of sea level rise will impact the implementation timing outlined in the Sea Level Rise Planning Framework.

Global SLR trends are being studied and monitored globally by climate scientists. The Intergovernmental Panel on Climate Change (IPCC) has produced Assessment Reports on the state of knowledge on climate change at regular intervals since 1990. The most recent report is the Fifth Assessment Report (AR5) which was finalized in November of 2014. In the past these reports have been released about every 6 years, therefore the next update could reasonably be expected in the year 2020 (Sixth Assessment Report -AR6), although it could be later.

The City of Vancouver should monitor federal and provincial interpretation of IPCC AR6 for guidance on sea level rise and total water level. Federal and provincial policy could provide updated guidance that the City should work to comply with based on its alignment with best practice and the latest science. If these policies are not updated in a timely fashion, however, regional partnerships could help support updates to the framework.

The City of Vancouver should work with municipal partners in the lower mainland and possibly more broadly in the Pacific Northwest to update the framework in the case of a lack of guidance of higher levels of government. Other municipalities such as the City of Surrey are actively working on monitoring and adapting to coastal hazard with SLR. Other jurisdictions in Washington State, Oregon, and California may provide to be valuable partners in updating guidance.

Data sources and expected timeline updates to sea level rise projections and total water components are summarised in Table 1. There are also regular tasks required to monitor sea level rise and total water levels. In addition there are milestones to watch for as they indicate that that valuable new information has been released or a funding opportunity may be available. (Table 2)

Component	Source	Expected Updates
Global sea level rise	IPCC AR 6	2022
Regional sea level rise	Natural Resources Canada Environment and Climate Change Canada Province of BC with Pacific Climate Impacts Consortium (Scoping Study)	Approx. 2024 December 2018 (based on AR5) and 2024 with updates from AR6 December 2018
Regional sea level rise and policy guidance	Province of BC (Ministry of Forests, Lands, Natural Resource Operations and Rural Development or Climate Action Secretariat)	Unknown, but after IPCC AR6
Local sea level rise and total water level	Canadian Hydrographic Service Pt. Atkinson Gauge Neighbouring municipalities statistical analyses	N/A Fraser Basin Council (December 2018) North Shore municipalities (December 2019)

Table 1. Data sources and expected timeline updates to sea level rise projections and total water components.

Winter Monitoring
<ul style="list-style-type: none"> • Total water level predictions for winter storms from StormSurgeBC • Follow schedule, triggers and actions from Fraser River Operational Monitoring Plan (2017)
Annual Review
<ul style="list-style-type: none"> • Perform basic statistical calibration and review of new gauge data and other gauge data utilized in emergency response guidelines and mapping tools. • Check-in with neighbouring local and regional governments and regional initiatives <ul style="list-style-type: none"> ○ Fraser Basin Council Lower Fraser Flood Management Strategy ○ Metro Vancouver ○ North shore municipalities (January 2020), City of Richmond, City of Delta, City of Surrey
Milestones and Actions
<ul style="list-style-type: none"> • Early 2022 – release of IPCC’s AR6 • Early 2024 – anticipated release of updated federal report on sea level rise from Natural Resources Canada. • 2024 – if no provincial or federal report is released by 2024 work with partners to develop update for Vancouver, BC, and/or Pacific Northwest.

Table 2. Monitoring and milestone schedule for sea level rise and coastal flood hazard information.

Alignment of Financial Support for “Sea Level Rise Design Challenge” with Innovation Fund Guidelines

Innovation Fund Guidelines	Project Alignment
<p>Aligns with City priorities</p> <p>Supports transformation and innovation in meeting City goals</p>	<p>The City of Vancouver is a recognized world leader in climate change mitigation and adaptation. The proposed Sea Level Rise Design Challenge directly supports the Climate Change Adaptation Strategy as well as, indirectly supporting, the Healthy City Strategy, Greenest City Strategy and the Rain City Strategy.</p> <p>Previous recommendations:</p> <ul style="list-style-type: none"> • Comprehensive city-level public engagement focussing on education and exploring adaptation options was recommended to a Council workshop on November 2, 2016 in the presentation titled Preparing for Sea Level Rise, Climate Change Adaptation Strategy Update as part of Phase II of the Coastal Flood Risk Assessment. • This project directly supports the 2017 Corporate Plan, Short-Term Priority 6F. Sea Level Rise Planning: “Ongoing implementation activities related to sea level rise planning, including the advancement of the Southlands and Fraser River flood protection programs.” <p>This project supports the City to take bold steps to plan for sea level rise now in order to prevent future risks and avoid major costs down the road.</p>
<p>Leverages 1:1 third-party investment</p>	<p>The use of Innovation Fund will be contingent upon securing at least 50% matching external funds.</p>
<p>One-time opportunity (2-year maximum) \$500,000 maximum/2 years</p>	<p>Request is for \$500,000 in funding. Funding may be allocated over a period of up to two years, in order to support planning and implementation of an innovative sea level rise engagement and</p>

	design program.
Demonstrates clear outcomes and transformation toward City of Vancouver goals	<p>For the Fraser River and False Creek flood plain areas, this is an opportunity to:</p> <ul style="list-style-type: none">• Make the City of Vancouver a world leader in flood management design by convening multi-disciplinary teams that integrate knowledge from local, regional and international experts• Advance and accelerate technical knowledge, feasibility studies and long term planning which will support future funding opportunities and shape capital and asset management planning.• Create innovative and implementable adaptation solutions in a relatively short time frame• Engage communities in a very impactful way <p>With approximately 13km² of the city at risk of flooding the Sea Level Rise Design Challenge provides an opportunity to advance resilience solutions across the City at a community-scale level and with input from residents, indigenous peoples, businesses and other experts.</p>